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Structure and Growth of Mite-induced Galls on *Coprosma robusta* Raoul

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Abstract

IRREGULARLY shaped parenchymatous galls of *Coprosma robusta* Raoul are caused by eriophyid mites which attack both male and female flowers. Galls derived from male flowers are darker in colour, contain less chlorophyll and have a shorter life than the galls derived from female flowers. In both types of gall, growth is governed by meristematic pouches which are analogous to the shoot apical meristem.

OF the twenty-eight different galls known to occur on native species of *Coprosma* (Lamb, 1960), one of the most conspicuous is a solid tumorous-looking proliferation which results from the infection of flowers and fruits by the eriophyid mite *Aceria cottieri* Lamb (Lamb, 1952). Both male and female trees of *Coprosma robusta* are often heavily covered with the galls. (Figs. 1 and 2).

The aims of the present investigations were to see whether any notable differences existed between galls of male and female trees, and to trace the developmental processes which give rise to the tissues of the gall.

MATERIALS AND METHODS

Male and female trees growing in Riccarton Bush, Christchurch, were observed once a week over a period of twelve months and on several subsequent occasions. Specimens of infected flowers and older galls were fixed throughout the year in Carnoy's fluid (with chloroform), embedded in paraffin, serially sectioned at 10μ, and stained in Safranin and Fast Green (Johansen, 1940). Free hand sections of living galls were also made.

OBSERVATIONS

Reinfection of the trees occurred when mites invaded male and female flowers as they opened in the spring. (Fig. 2).

On male trees, the infested flowers rapidly gave rise to a rough-surfaced growth with a dark purplish coloration and no recognisable trace of floral structures. Uninfected male flowers rapidly shrivelled, making the surviving galls the most striking feature of the tree.

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On female trees, many of the flowers gave rise to healthy green fruits alongside fruits which were partially galled. (Fig. 1.). Other flowers became entirely transformed into galls, lacking any sign of pericarp. In general, galls on female trees contained less purple coloration and were greener than the galls of male trees.

At the end of four months it appeared that galls of male trees were, with few exceptions, more abundant, darker in colour, and more prone to decay than those of female trees.

When no trace of flower or fruit structure remains, the galls of female trees are similar in shape to the galls on male trees. The gall surface is thrown up into rough irregular folds which are covered in simple epidermal hairs. A reddish purple pigment is present in erratic clusters of superficial cells. Pigment-containing cells are generally more numerous in galls of male trees. On the other hand, much less chlorophyll is found in the outer tissues of these galls than in galls growing on female trees.

The mite colonies live in cavities hidden within the deeper tissues of the gall. The colonies include gravid females and developing eggs which give rise to a new generation within the cavities.

At the outset of the disease, small depressions of meristematic cells arise on the flower parts where mites have intruded. The subsequent course of events is essentially similar in galls from both male and female flowers, and results in the growth of a small meristematic pocket of cells (Fig. 3) which encloses the mites and generates the parenchymatous folds which eventually constitute the outer regions of the gall.

Vascular tissue differentiates copiously, branching around the bottom of the pouch-like meristems (Fig. 4), and reticulating with the existing vascular system of the flower.

In both types of gall, the bulk of the tissue is parenchymatous, being added to as the pouch meristems continue to grow and increase in number, until the gall is about half an inch in diameter.

The mite galls of *Coprosma robusta* have certain features in common with those of *Hoheria sexstylosa* Col., the most notable being the possession of a " pouch meristem " enclosing the mites.

DISCUSSION

It appears that the mite galls of *Coprosma robusta* which have the least chlorophyll content are the earliest to show signs of decay. The galls of female trees usually have a higher chlorophyll content, and presumably a higher rate of photosynthesis than the galls of male trees. Decay of these galls may thus result from inadequate photosynthesis.

Despite differences in chlorophyll content, pigmentation, and life span, the galls on male and female trees develop in a similar way.

The tissue lining each cavity, in which the mites live and feed, is in fact a concave pouch-like meristem, notwithstanding the nutritive value to the mites. In its growth activity and relation to the circumjacent vascular tissue, the " pouch meristem " is analogous to a normal shoot apical meristem giving rise to irregular parenchymatous folds instead of leaf primordia. In an earlier investigation of mite galls of *Hoheria sexstylosa* Col. (Arnold, 1965), a comparable morphogenetic situation was found.

Although the causal mites in each case are members of the same family, the trees *Hoheria* and *Coprosma* belong to families which show no close relationship. While resembling the *Coprosma* galls in the possession of a " pouch meristem " and

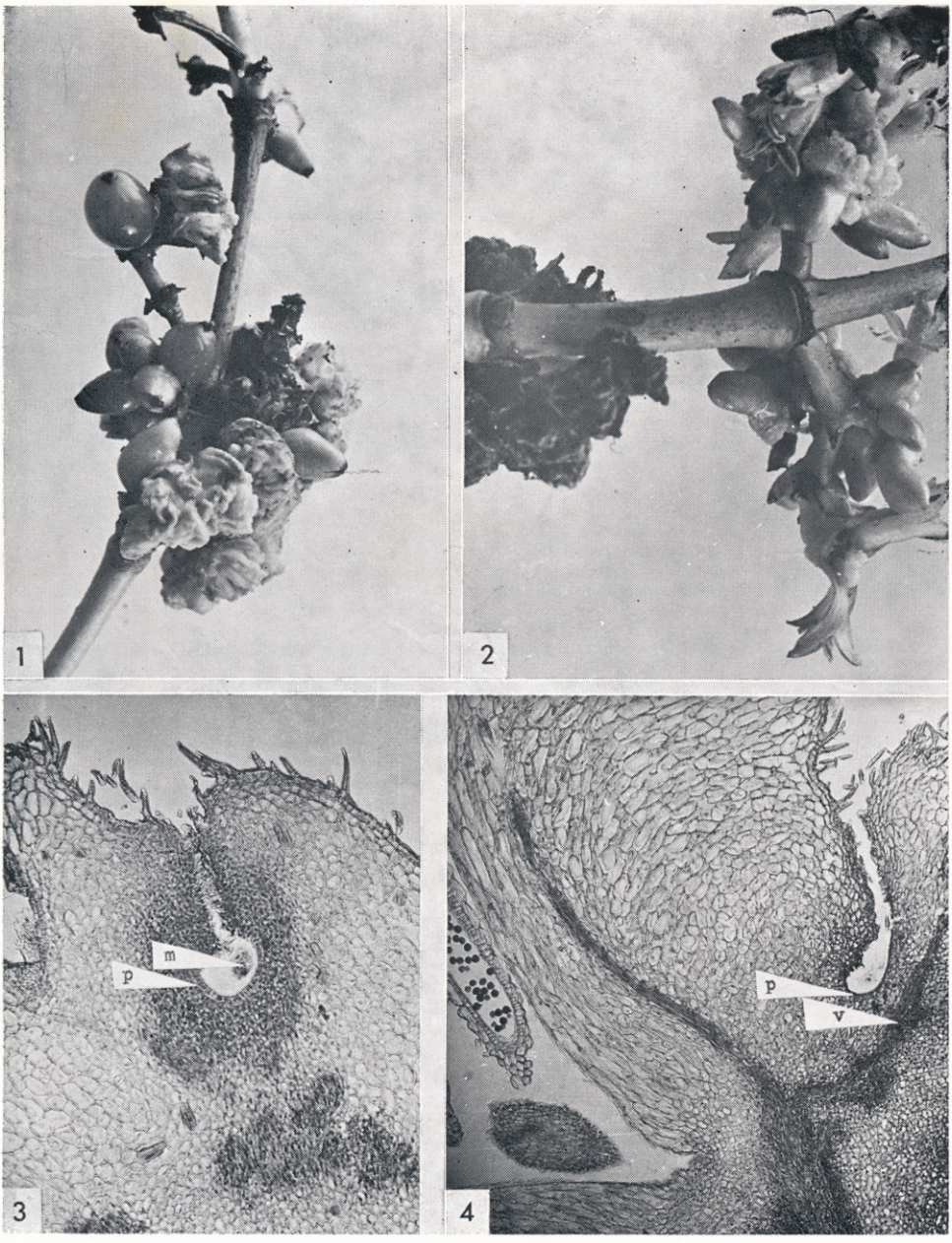

FIG. 1.—Galls on female tree ×1. FIG. 2.—Galls on male tree ×1½. FIG. 3.—Section through "pouch meristem" ×40. p = pouch meristem m = mite. FIG. 4.—Section through gall showing development of vascular tissue ×40. p = pouch meristem v = vascular strand forming.

well-developed vascular tissues, the galls of *Hoheria* differ in the production of an orderly periderm and in the capacity for more enduring growth.

However, in *Coprosma robusta* the greener galls, particularly on female trees, provide a fairly stable overwintering haven in which the mite colonies can grow and multiply until further flowers become available for invasion in the spring.

Although the incidence of galling of male flowers may be very high, it does not entirely prevent the formation of pollen; while on female trees fruit development continues alongside the conversion of flowers into galls. As with the gall mites of *Hoheria sexstylosa* the parasitic activities of *Aceria cottieri* appear to represent a fairly high level of evolutionary adaptation.

Despite the outward appearance of a tumour-like irregularity of form, the galls of *Coprosma robusta* like those of *Hoheria sexstylosa* show a remarkable degree of underlying orderliness, which is attributable to the activity of the well-organised " pouch meristem ".

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